PATENT SPECIFICATION

DRAWINGS ATTACHED

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The inventors of this invention in the sense of being the devisers thereof within the meaning of Section 16 of the Patents Act 1949, are Manfred Haeberle, Guenther John, Albert Wuerflinger and Johann Zizlsperger, citizens of the Federal Republic of Germany, residing, respectively, at 10 Boecklinstrasse, Mannheim; 47 Franz-von-Sickingen-Strasse, Ludwigshafen/Rhein; 35 Schwalbenweg, Ludwigshafen/Rhein; and 22 Carl-Bosch-Ring, Frankenthal/Pfalz; Federal Republic of Germany.

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COMPLETE SPECIFICATION

Fluidisation Reactor

We, BADISCHE ANILIN- & SODA-FABRIK AKTIENGESELLSCHAFT, a German Joint Stock Company, of Ludwigshafen/Rhein, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to a fluidization reactor and particularly to a reactor in which gas distributor plates are arranged at various levels.

It is known that improved mixing of the fluidized solid with the fluidizing gas can be achieved in a fluidization reactor by providing for a plurality of layers separate from each other by installing grates, instead of having a single fluidized bed.

In the case of solids having a wide grain size spectrum, for example those in which the ratio of grain diameters is more than 1:20 or which readily tend to cake together at elevated temperatures, it is not possible to achieve satisfactory fluidization. In the case of such products, the fluidizing gas, even when the height of the bed is small, forms gas bubbles which increase in size as they rise and therefore flow through the bed without adequately contacting the solid. This disadvantage is particularly evident in the polymerization of gases, for example of ethylene, carried out in a fluidized bed when the temperature of the bed is kept close below the melting point of the polymer formed. The surface of the solid formed is consequently slightly tacky and this results in an irreversible fusing together of the solid and consequently a collapse of the fluidized bed, particularly when the height of the bed is more than 0.3 m. The provision of a plurality of fluidized beds arranged one above another in one reactor by the installation of grates distributed throughout the entire height of the reactor has proved to be unfavourable because the fluidizing gas during its passage through the individual beds gradually becomes heated up so that a uniform product is not obtained in the individual beds by reason of the different reaction temperatures.

It is an object of the present invention to provide a fluidization reactor for the treatment of granular solids having a wide grain spectrum and/or caking tendencies in an upwardly directed stream of gas or for the production of granular solids having a wide grain spectrum and/or caking tendencies from the gases serving for fluidization, by which reactor the said disadvantages are avoided.

This object is achieved by a fluidization reactor having gas distributor plates located at different levels, when the openings in the gas distributor plates are first constricted in the direction of flow of the gas and then widened and the total area of the openings at the narrowest points is made equal to 30 to 70%, preferably 40 to 60%, of the total cross-sectional area of the fluidization reactor.

The openings in the gas distributor plates

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may consist of holes of circular cross-section shaped as double cones. The diameter of the narrowest point in these holes is advantageously such that it is at least three times the diameter of the coarsest grain fraction in the reactor. It is not necessary for the diameters of the individual holes to be the same. On the contrary, better distribution of gas is achieved if the diameters of the holes becomes greater from the middle of the plate to the reactor wall. The diameter of the holes provided in the plate in the neighbourhood of the reactor wall may for example be up to three times the diameter of the holes in the center of the plate. To avoid accumulation of product, the holes should be arranged so that the area of the upper and lower faces on the plates between the holes is at a minimum.

The openings in the gas distributor plates may also provided so that they form a number of concentric slots or a single spiral slot, the narrowest width of each slot being at least twice the diameter of the coarsest grain fraction. The width of the slot or slots may increase from the center and the width of the slot or slots in the neighborhood of the reactor wall may be up to two times as great as the width of the slot or slots in the neighborhood of the center. The distributor plates may for example be made of sections of refractory material having sharp edges directed upwardly and downwardly.

A large number of gas distributor plates may be arranged one above another in the reactor depending on the prevailing conditions, such as gas velocity, grain diameter, the properties of the solid to be fluidized and the dimensions of the fluidization reactor. The distance between individual plates may accordingly vary widely and may be for example 0.1 to 1 m. When the products do not fluidize easily it is advantageous to choose smaller distances than when they do fluidize easily. The distances between the individual plates may be the same or may increase or decrease upwardly.

The plates may have the same diameter as the reactor at the particular level or may be somewhat smaller.

The ratio of height to diameter of a fluidized bed in a reactor provided with gas distributor plates according to this invention may vary within wide limits and is for example advantageously from 0.5:1 to 10:1.

With the said distributor plates it is possible to increase considerably the height of the fluidized bed in a reactor without bubble formation being observed. The vertical circulatory flow of solid which is essential for homogeneous mixing of the bed and such as occurs in fluidized beds having the above-mentioned ratio of height to diameter, is not disturbed by the installation in a fluidization reactor of distributor plates according to this invention. The solid may therefore pass unhindered through the plates in the direction of the gas flow and in the opposite direction. The solid flows upward preferentially in the middle of the reactor while a downward flow of the solid forms preferentially in the edge zones. Contrasted with the prior art distributor plates in shelf reactors, no zones of low solid density form beneath the plates. When using these plates, the height of the bed is limited merely by the characteristics of the process in question, for example in exothermic processes by the permissible temperature difference between the lower and upper portions of the fluidized bed. For example in the catalytic gas phase polymerization of ethylene, a bed height of 2 m may be exceeded with a diameter of the reactor of 0.35 m, homogeneous mixing of solid and gas being achieved throughout the entire height. The solid is mixed well in horizontal and vertical directions and this ensures constancy in the properties of the product. Furthermore the gas distributor plates bring about a diminution in eruptions of solid at the surface of the bed and it is therefore possible to keep the unusable dead space above the bed small or to pass larger amounts of gas through the fluidized bed. This has the advantage not only that the space-time yield is increased but also that in exothermic processes in which the fluidizing gas also serves to carry away heat, rapid withdrawal of the heat formed is possible.

If the said perforated plates are located in the lower tapering portion of a reactor, it is possible in a simple way to carry out a classification of the solid discharged from the reactor. By regulating the rate of flow of the gas through the holes in the plates it is possible to limit the passage of granular material to a grain size having a specific minimum grain diameter.

Apparatus according to this invention will be described in greater detail with reference to the accompanying diagrammatic drawings, Figures 1 to 4.

A reactor provided with distributor plates according to the invention is shown by way of example in Figure 1.

Gas is introduced at 1 into the reactor 2 and first passes through an annular slot 3 in the conical lower portion of the reactor. Gas distributor plates 4 have annular slots arranged concentrically. Solid is withdrawn from the reactor through a discharge 5, while solid can be introduced into the reactor through a feed 6. Gases are removed from the reactor through a pipe 7 after having passed through a separator 8.

Figure 2 shows the lower portion of a reactor with which it is possible to discharge solid having a definite minimum grain diameter separately from other solid having a smaller grain diameter. This reactor differs

mainly from the reactor shown in Figure 1 in the fact that an additional pipe 21 is provided beneath the lowermost gas distributor plate for the discharge of the coarser grain fractions, while the finer grain fractions are discharged through a discharge 22 located above the second distributor plate.

Figure 3 shows on a large scale and in section a gas distributor plate having as openings concentric apertures. The plate is supported at the appropriate height by a shaft 31. 32 and 33 are the upper and lower faces of the plates.

Figure 4 is a plan view of a plate having annular slots which is formed by iron bars 41 tapering to a point at the top and bottom which are supported on a tube 42.

The invention will be further illustrated by the following examples:

EXAMPLE 1

Ethylene is passed at 1 into a reactor as shown in Figure 1 which has a height of 2 m and a diameter of about 0.35 m. The reactor is charged with a granular catalyst consisting of silica and aluminium oxide as a carrier to which 2% of chromium has been applied. The catalyst has an average grain diameter of 35 to 500 microns. The reactor is provided with four gas distributor plates of the type shown in Figure 3 arranged at intervals of 30 cm. The total free area at the narrowest point in these plates (expressed as a percentage of the total area of the reactor at the level in question) is 60% in the bottom plate, 50% in each of the two intermediate plates and 40% in the top plate. The diameter of the holes at their uppermost and widest point in the plates having 50% free area is 2.32 cm and the narrowest central area of the double-tapered holes is 1.5 cm.

Ethylene is passed into this reactor through the inlet 1 and a fluidized bed is maintained at a height of 1.4 m. The fluidized bed is kept at a temperature of 105°C and a pressure of 35 atmospheres gauge. 8 kg per hour of polyethylene having a molecular weight of 400,000 and an ash content of 0.02% by weight is withdrawn through the discharge 5.

EXAMPLE 2

The reactor used is as described in Example 1 but having a lower portion provided with an additional discharge for coarse-grained solid as shown in Figure 2. Ethylene is polymerized to polyethylene in this reactor under the same conditions as are described in Example 1. In the tapering lower portion of the reactor, a distributor plate is provided having a diameter of 0.152 m, equivalent to the reactor diameter at this point. The free area at the narrowest point is 50% of the total area of the reactor at this point. The gas velocity is 80 cm/sec. With the height of the fluidized bed, the temperature and the pressure the same as in Example 1, 8 kg per hour of polyethylene having a molecular weight of 400,000 and a grain size above 0.8 mm can be removed. The ash content of the product is less than 0.01% because in consequence of the classification, only coarse grains of low ash content are discharged, whereas the smaller grains remain in the reactor and are increased in size by further polymerization.

WHAT WE CLAIM IS:—

1. A fluidization reactor having gas distributor plates arranged at different levels wherein the openings in the gas distributor plates are first constricted in the direction of flow of the gas and then widened and the total area of the openings at the narrowest points is 30 to 70% of the total area of the fluidization reactor at that level.

2. A fluidization reactor as claimed in claim 1 wherein the total area of the openings at their narrowest point is 40 to 60% of the total area of the fluidization reactor at the level concerned.

3. A fluidization reactor as claimed in claim 1 or 2 wherein the openings in the gas distributor plates are of circular cross-section.

4. A fluidization reactor as claimed in claim 1 or 2 wherein the openings in the gas distributor plates consist of concentric or spiral slots.

5. A fluidization reactor as claimed in any of claims 1 to 4 wherein the openings in the gas distributor plates are circular, or concentric or spiral slots and have a smaller diameter or width in the middle of the plate than near the reactor wall.

6. A fluidization reactor as claimed in claim 5 wherein the circular openings in the gas distributor plates in the neighborhood of the reactor wall are up to three times as wide as the openings in the middle of the plates.

7. A fluidization reactor as claimed in claim 5 wherein the concentric or spiral slots in the gas distributor plates in the neighborhood of the reactor wall are up to twice as wide as the slots in the middle of the plates.

8. A fluidization reactor as claimed in any of claims 4, 5 and 7 wherein the gas distributor plates are formed of sections of refractory material having sharp edges directed upwardly and downwardly.

9. A fluidization reactor substantially as herein described and shown in any of the Figures of the accompanying drawings.

10. A fluidization reactor substantially as

described in either of the foregoing Examples.

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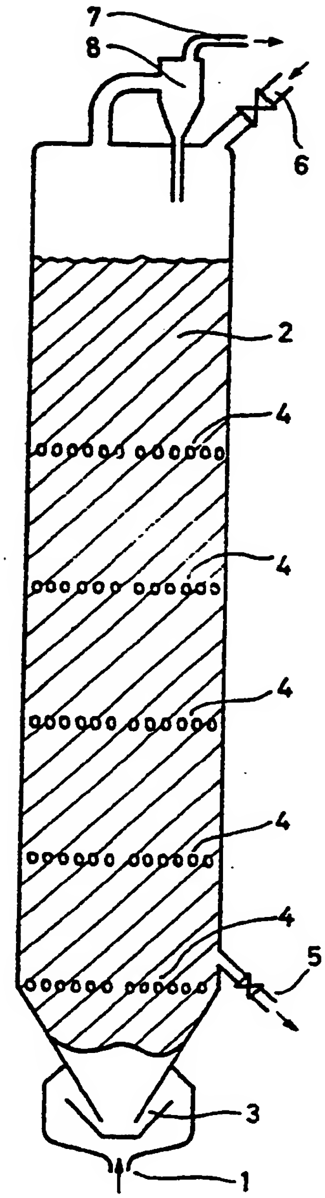
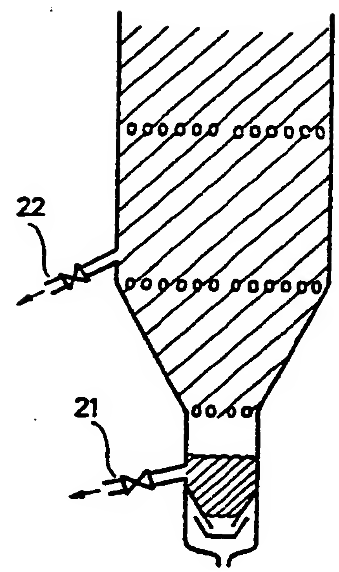


Fig. 1

Fig. 2



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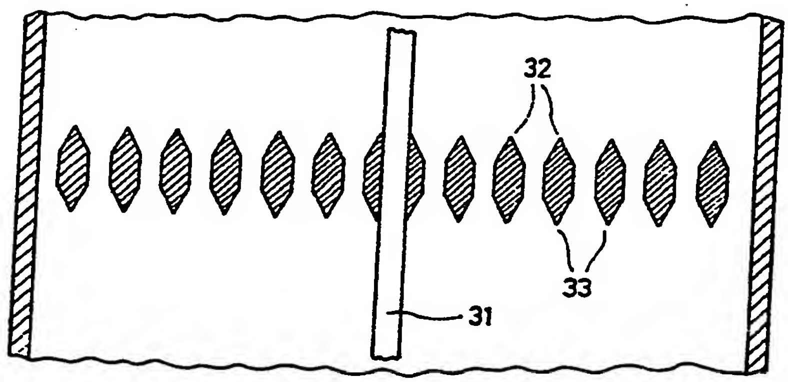
Sheets 1 & 2



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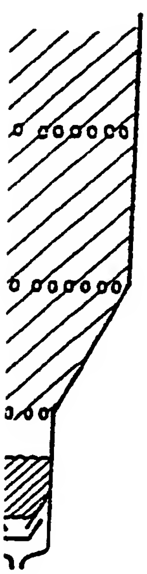

Fig. 3

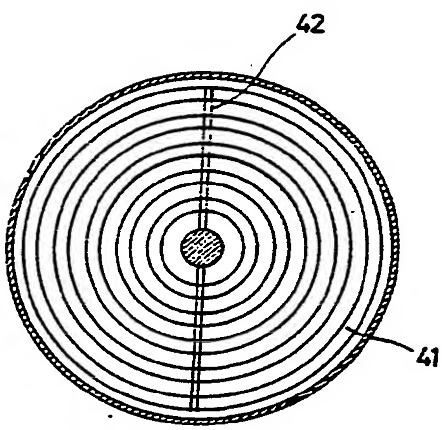

Fig. 4

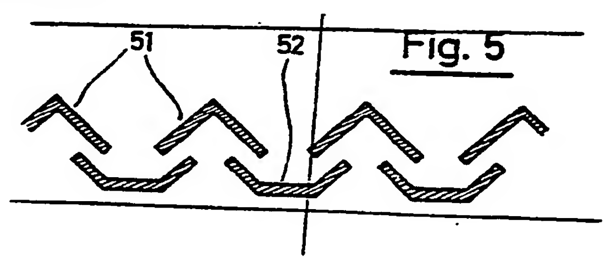

Fig. 5

1014205 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 1 & 2

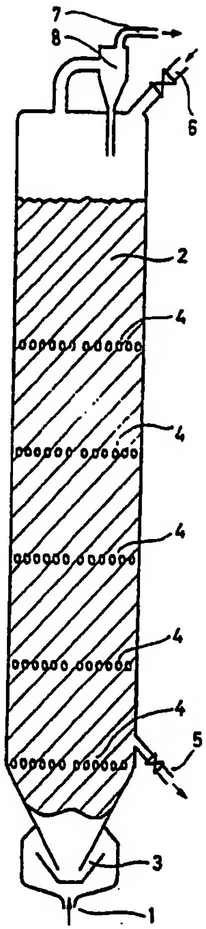

Fig. 1

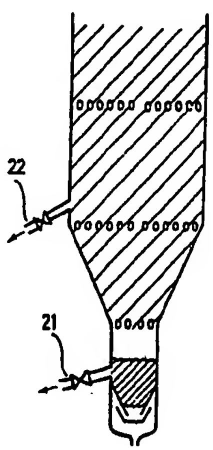

Fig. 2

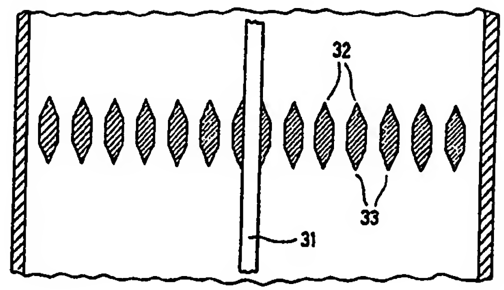

Fig. 3

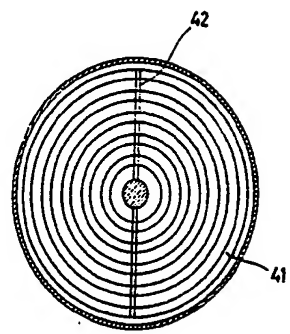

Fig. 4

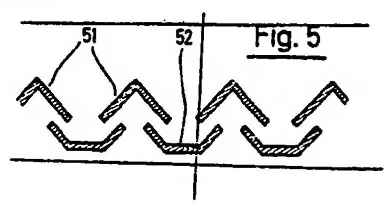

Fig. 5